(Translation)

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[Title of the Invention] REFLECTION TYPE LIQUID CRYSTAL DISPLAY DEVICE AND A PRODUCTION METHOD THEREOF

[Abstract]
[Purpose] To obtain a reflection type liquid crystal display device having a good reflectivity with reproducibility.

[Constitution] Forming a cylinder having a circular convex portion with a diameter of 3 to 50 μm in a liquid crystal layer side on a reflection plate, so that adjacent cylinders are separated by more than or equal to 1 μm to form a reflection electrode on the cylinder.

[Claims]
1. In a reflection type liquid crystal display device configured by coating an insulation layer having concavity and convexity in a liquid crystal layer side on one substrate of a pair of transparent substrates oppositely disposed via a liquid crystal layer; forming a reflection plate having a plurality of reflection electrodes which are display pixels for reflecting

an incident light from the other substrate side on the insulation layer; and forming a common electrode having a transparency over almost the whole surface in a liquid crystal layer side on the other substrate, the reflection type liquid crystal display device is characterized in that the convex portion is a columnar body with the diameter of 3 to 50 μm, the position of the columnar body is irregular, and the adjacent convex portions are separated by more than or equal to 1 μm one another.

2. In a production method of reflection type liquid crystal display device configured by coating an insulation layer having concavity and convexity in a liquid crystal layer side on one substrate of a pair of transparent substrate oppositely disposed via a liquid crystal layer; forming a reflection plate having a plurality of reflection electrodes which are display pixels for reflecting an incident light from other substrate side on the insulation layer; and forming a common electrode having a transparency over almost the whole surface in a liquid crystal layer side on the other substrate, the method being characterized by:

coating uniformly an inorganic insulation layer on the reflection plate;

coating a photoresist layer on the inorganic layer;

further applying a photomask formed so that circular light shielding areas with diameter of 3 to 50 μm are irregularly formed and the adjacent light shielding areas are separated by more than or equal to 1 μm to the photoresist layer to radiate a light to form concavity and convexity on the photoresist layer;

performing etching to form concavity and convexity portions corresponding to the light shielding area in the organic

insulation layer; and

forming a metal thin film thereon.

3. The production method of reflection type liquid crystal display device according to claim 2, characterized in that the mask is designed by mirror inversing a unit pattern of a square shape having a side of 100 to 200 μm.

[Detailed Description of the Invention]

[0001]

[Industrial applicability] The present invention relates to a reflection type liquid crystal display device for reflecting an incident light to display, without using a back light.

[0002]

[Prior Art] Recently, applications of liquid crystal display device to a word processor, a laptop personal computer, a pocket television and the like are rapidly increasing. In particular, in a liquid crystal display device, reflection type liquid crystal display devices which reflect incident light from outside to display have low power consumption because a backlight, being a light source, is not needed; therefore, it is eye-catching because it is thin and can be low weight.

[0003] Conventionally, TN (Twisted Nematic) type, and STN (Super Twisted Nematic) type are used for a reflection type liquid crystal display device. However, in these method, half of the intensity of natural light is not substantially utilized for display due to a polarization plate; therefore, the problem arises that a display becomes dark.

[0004] To this problem, a display mode which does not use a polarization plate to effectively utilize all of light beam of a natural light is presented. As an example of such mode,

a phase transition type guest/host method is presented (D. L. White and G. N. Taylor: J. Appl. Phys. 45 4718 1974). In this display mode, a phenomenon of cholesteric/nematic phase transition by an electric field is utilized. A reflection type multicolor display in which a micro color filter is further combined to the phase transition type guest/host method is also presented (Tohru Koizumi and Tatsuo Uchida, Proceedings of the SID, Vol. 29, 157, 1988).

[0005] In order to obtain a further bright display in a mode which does not require such a polarization plate, an intensity of light which scatters in the vertical direction to a display screen is required to be increased for incident light from every angle. For this purpose, it is required to produce a reflection plate having an optimal reflection property. The above-described documents describe a reflection plate for roughening a surface of a substrate consisting of glass and the like by an abrasive compound, varying an etching time by hydrofluoric acid to control a concavity and convexity of the surface and forming silver thin film on the concavity and convexity.

[0006] Figure 11 is a plan view of a reflection plate 2a having a thin film transistor (hereinafter, referred to as TFT) 1 which is a switching element used for an active matrix method, and Figure 12 is a cross-section viewed from a cross-sectional line XI-XI shown in Figure 11. In the Figures, a plurality of gate bus wirings 3 consisting of chromium or tantalum are formed in parallel with one another, and gate electrode 4 is arranged being branched from the gate bus wirings 3. The gate bus wirings 3 function as a scanning line.

[0007] Covering gate bus electrodes 4, a gate insulation film 5 consisting of silicon nitride (SiNx), silicon oxide (SiOx) and the like is formed on the whole surface of the substrate 2. On the gate insulation film 5 over the gate electrode 4, a semiconductor layer 6 consisting of amorphous silicon (hereinafter, referred to as a-Si), polysilicon, CdSe and the like is formed. At one end of the semiconductor layer 6, a source electrode 7 consisting of titan, molybdenum, aluminum and the like is overlapped and formed. In addition, at the other end of the semiconductor layer 6 is a drain electrode 8 consisting of titan, molybdenum, aluminum and the like similar to the source electrode 7. At the opposite end of the semiconductor layer 6 of the drain electrode 8, pixel electrode 9 consisting of ITO (Indium Tin Oxide) is overlapped and formed.

[0008] As shown in Figure 11, the source electrode 7 is connected with a source bus wiring 10 crossing the gate bus wiring 3 across the above-described gate insulation film 5. The source bus wiring 10 functions also as a signal line. The source bus wiring 10 is also formed of similar metal to those of the source electrode 7. The gate electrode 4, the gate insulation film 5, the semiconductor layer 6, the source electrode 7 and drain electrode 8 configure a TFT 1, and the TFT 1 have a function as a switching element.

[0009] When applying the reflection plate 2a having the TFT 1 shown in Figure 11 and Figure 12, not only a pixel electrode 9 is formed with a metal having light reflectivity such as aluminum or silver, but concavity and convexity is required to be formed on the gate insulation film 5. Generally, it is difficult to form uniformly tapered concavity and convexity

in an insulation film 5 consisting of inorganic substance.

[0010] Figure 13 is a plan view of a reflection plate 12a having TFT 11 used for an active matrix method, and Figure 14 is a cross-section viewed from cross section line XII-XII shown in Figure 13. In the Figures, a plurality of gate bus wirings 13 consisting of chromium or tantalum are formed in parallel with one another on an insulating substrate 12 such as a glalss, and gate electrode 14 is arranged being branched from the gate bus wirings 13. The gate bus wirings 13 function as a scanning line.

[0011] Covering gate electrodes 14, gate insulation film 15 consisting of silicon nitride (SiNx), silicon oxide (SiOx) and the like on the whole surface of the substrate 12. On the gate insulation film 15 over the gate electrode 14, a semiconductor layer 16 consisting of a-Si and the like is formed. At both ends of the semiconductor layer 16, a contact layer 17 consisting of a-Si and the like is formed. On one side of the contact layer 17, a source electrode 18 is overlapped and formed, and on the other side of the contact layer 17, a drain electrode 19 is overlapped and formed. A source bus wiring 10 is connected to the source electrode 18, wherein the source bus wiring 10 functions as s signal line crossing the gate bus wiring 13 across the above-described gate insulation film 15. The gate electrode 14, the gate insulation film 15, the semiconductor layer 16, the contact layer 17, the source electrode 18 and drain electrode 19 configure a TFT 11.

[0012] Further, an organic insulation film 20 having a plurality of convex portions 20a on the TFT 11 and having a contact hole 21 on the drain electrode 19 is formed. On the organic insulation

film 20, a reflection electrode 22 is formed, and the reflection electrode 22 is connected to the drain electrode 19 via the contact hole 21.

[0013] As described above, by forming the organic insulation film 20 on the reflection plate 12a in which TFT 11 is formed, convex portion 20a is easily formed on a surface of the organic insulation film 20. In addition, by forming a reflection electrode 22 on the organic insulation film 20 having a convex portion 20a, a reflection electrode 22 with concavity and convexity is easily formed.

[0014]

[Problems to be Solved by the Invention] In a reflection plate described in the above document, since concave and convex portions are formed by scratching a glass substrate with an abrasive compound, concave and convex portions with uniform shape cannot be formed. In addition, since there are problems that repeatability of the shape of the concave and convex portions is bad and that the shape of the concave and convex portions is not patterned, using such a glass substrate cannot provide a reflection type liquid crystal display device having a good reflection property with good repeatability. Furthermore, this method cannot be applied to a reflection plate having a switching element such as a TFT because of the possibility of damage to the device.

[0015] In addition, as shown in Figure 11 and Figure 12 above, when forming a reflection electrode 9 and a source bus wiring 10 on the gate insulation film 5, a slit 9a is formed so that the reflection electrode 9 and the source bus wiring 10 do not electrically contact. However, as shown in aforementioned

Figure 13 and Figure 14, if forming the source bus wiring 23 on the gate insulation film 15 and the reflection electrode 22 on the organic insulation film 20, the above-described slit 9a is not needed.

[0016] In order to improve a brightness of display, the larger reflection electrode 22 is more preferable. Therefore, in Figure 13 and Figure 14, an end portion of the reflection electrode 22 is also formed on the source bus wiring 23 via the organic insulation film 20; therefore, the size of the reflection electrode 22 is larger than that of the reflection electrode 9 shown in Figure 11 and Figure 12.

[0017] However, since the organic insulation film 20 has concavity and convexity, a concave portion becomes deeper; therefore, if there is an etching failure wherein a bottom 20b of the concave portion contacts on the source bus wiring 23, an insulation by the organic insulation film 20 is not formed; therefore, there arises a problem of insulation failure between the reflection electrode 22 formed on the organic insulation film 20 and the source bus wiring 23.

[0018] In addition, since the organic insulation film 20 having the convex portion 20a is formed on the whole surface of the substrate 12, when patterning the reflection electrode 22, concavity and convexity is caused at the end portion of the reflection electrode 22 by the convex portion 20a and thereby the problem arises that a patterning failure of the reflection electrode 22 is caused.

[0019] The purpose of the present invention is to solve the above-described problem by providing a reflection type liquid crystal display device comprising a reflection electrode having

a good reflection property and a production method thereof.

[0020]

[Means for Solving the Problem] The present invention is that in a reflection type liquid crystal display device configured by coating an insulation layer having concavity and convexity in a liquid crystal layer side on one substrate of a pair of transparents substrate oppositely disposed via a liquid crystal layer; forming a reflection plate having a plurality of reflection electrodes which are display pixel for reflecting an incident light from the other substrate side on the insulation layer; and forming a common electrode having a transparency over almost the whole surface in a liquid crystal layer side on the other substrate, the reflection type liquid crystal display device being characterized in that the convex portion is a columnar body with a diameter of 3 to 50 µm and the position of the columnar body is irregular, and the adjacent convex portions are separated by more than or equal to 1 µm one another.

[0021] In addition, the present invention is that in a production method of a reflection type liquid crystal display device configured by: coating an insulation layer having concavity and convexity in a liquid crystal layer side on one substrate of a pair of transparent substrates oppositely disposed via a liquid crystal layer; forming a reflection plate having a plurality of reflection electrodes which are display pixels for reflecting an incident light from the other substrate side on the insulation layer; and forming a common electrode having a transparency over almost the whole surface in a liquid crystal layer side on the other substrate, the method is characterized by: coating uniformly an inorganic insulation layer on the

reflection plate; coating a photoresist layer on the inorganic layer; further applying a photomask formed so that circular light shielding areas with diameter of 3 to 50 μm are irregularly formed and the adjacent light shielding areas are separated by more than or equal to 1 μm to the photoresist layer to radiate a light to form concavity and convexity on the photoresist layer; performing etching to form concavity and convexity portions corresponding to the light shielding area in the organic insulation layer; and forming a metal thin film thereon.

[0022] In addition, the present invention is characterized in that the mask is designed by mirror inversing a unit pattern of square shape having a side of 100 to 200 μm.

[0023]

[Operation] According to the present invention, in the reflection type liquid crystal display device, a reflection plate having a reflection electrode is formed separated by a convex portion mixed with circles of the diameter of 3 to 50 μm, and the adjacent convex portions are formed separated by more than or equal to 1 μm; therefore, the position is irregular. In addition, since formation of concavity and convexity is performed by using a mask, the depth of a concave portion is constant; thereby, without damaging an element by insulation failure, unevenness of exposure is prevented by separating convex portions by more than or equal to 1 μm to obtain a bright reflection property.

[0024] In addition, preferably, a simplification of mask design of random pattern is realized by mirror inversing a unit pattern of square shape having a side of 100 to 200 μm, and a bright reflection property is obtained in which a joint of unit pattern

is not linear and is scattered by a mirror inversion.

[0025] Further, if a parallax is a problem, the constitution that the surface in which a thin film having a reflection function of a reflection plate being formed is located at a liquid crystal layer side, that is, a position almost adjacent to the liquid crystal layer can be used.

[0026] In addition, the thin film having the reflection function may be an insulating thin film of notch type filter using a dielectric mirror or a cholesteric liquid, or there is no problem that the thin film may be metal thin film. Furthermore, in this case, a function as an electrode opposing the electrode formed on the transparent substrate across the liquid crystal layer can be added.

[0027]

[Embodiments of the Invention] In the following, the present invention will be explained more concretely by referring embodiments.

[0028] Figure 1 is a cross-sectional view of a reflection type liquid crystal display device 30 which is an embodiment of the present invention, and Figure 2 is a plan view of a reflection plate 52 shown in Figure 1. On an insulation substrate 31 consisting of glass and the like, a plurality of gate bus wirings 32 consisting of chromium, tantalum and the like are disposed in parallel to one another, and a gate electrode 33 is branched from the gate bus wiring 32. The gate bus wiring 32 functions as a scanning line.

[0029] Covering the gate electrode 33, gate insulation film 34 consisting of silicon nitride (SiNx), silicon oxide (SiOx) and the like is formed on the whole surface of the substrate

31. On the gate insulation film 34 over the gate electrode 33, a semiconductor layer 35 consisting of a-Si, polysilicon, CdSe and the like is formed. At both ends of the semiconductor layer 35, a contact electrode 41 consisting of a-Si and the like is formed. On one side of the contact electrode 41, a source electrode 36 consisting of titanium, molybdenum, aluminum and the like is overlapped and formed, and on the other side of contact electrode 41, a drain electrode 37 consisting of titanium, molybdenum, aluminum and the like is formed similar to the source electrode 36.

[0030] As shown in Figure 2, a source bus wiring 39 is connected to the source electrode 36, wherein the source bus wiring 10 crosses the gate bus wiring 32 across the above-described gate insulation film 34. The source bus wiring 39 functions as a signal line. The source bus wiring 39 is also formed with a metal similar to the source electrode 36. The gate electrode 33, the gate insulation film 34, the semiconductor layer 35, the source electrode 36 and the drain electrode 37 configure a TFT 40, and the TFT 40 has a function of a switching element.

[0031] Covering the gate bus wiring 32, the source bus wiring 39 and TFT 40, an organic insulation layer 42 is formed on the whole surface of the substrate 31. In an area where a reflection electrode 38 is formed in the organic insulation film 42, a tapering convex portion with the cross section shape of the bottom being the diameter of 3 to 50 μm, preferably, that of 5 to 20 μm with the height of H and the adjacent convex portion being separated greater than or equal to 1 μm are formed. In addition, in a drain electrode 37 portion, a contact hole 43 is formed. Due to a forming method of the organic insulation

film 42 or a process problem of forming a contact hole 43 on the organic insulation film 42 and for reducing a variation of thickness of cell when forming a liquid crystal display device 30, the height H of the convex portion is preferably less than or equal to 10 μm (generally, the thickness of a cell is less than or equal to 10 μm). A reflection electrode 38 consisting of aluminum, silver and the like is formed on a forming area of the circular convex portion 42a of the organic insulation film 42, and the reflection electrode 38 is connected to the drain electrode 37 at the contact hole 43. Further thereon, an orientation film 44 is formed.

[0032] On the other substrate 45, a color filter 46 is formed. At the position opposing the reflection electrode 38 of the substrate 31 in the color filter 46, a filter 46a of magenta or green is formed, and at the position not opposing the reflection electrode 38, a filter 46b of black is formed. On the whole surface of the color filter 46, a transparent electrode 47 consisting of ITO and the like is formed and further thereon an orientation film 48 is formed.

[0033] Both substrates 31 and 45 are stuck oppositely so that the reflection electrode 38 and the filter 46a coincide, and then a liquid crystal 49 is injected between the substrates to complete a reflection type liquid crystal display device 30.

[0034] Figure 3 is a process chart for explaining a method for forming the reflection electrode 38 having a circular concavity and convexity shown in Figure 1 and Figure 2 on the substrate 31, Figure 4 is a cross section for explaining a forming method shown in Figure 3, and Figure 5 is a plan view of a mask 51

used in a process s7 of Figure 3. Figure 4 (1) shows a process s4 of Figure 3, Figure 4(2) shows a process s7 of Figure 3, Figure 4(3) shows a process s8 of Figure 3 and Figure 4(4) shows a process s9 of Figure 3.

[0035] In a process s1, a tantalum metal layer with the thickness of 3000 A is formed on an insulation substrate 31 consisting of glass and the like by a sputtering method, the metal layer is patterned with a photolithograph method and an etching to form a gate bus wiring 32 and a gate electrode 33. In a process s2, a gate insulation film 34 consisting of silicon nitride with the thickness of 4000 A is formed by a plasma CVD method.

[0036] In process s3, an a-Si layer of 1000A thickness which forms a semiconductor layer 35, and an n' type a-Si layer of 400A thickness which forms a contact layer 41 are continuously formed in this order. Then, formed n' type a-Si layer and a-Si layer are patterned to form the semiconductor 35 and the contact layer 41. In process s4, a molybdenum metal of 2000A thickness is formed on the whole surface of the substrate 31 by a sputtering method, then the molybdenum metal layer is patterned to form a source electrode 36, a drain electrode 37 and a source bus wiring 39 to complete a TFT 40. Figure 4(1) is a cross section of a reflection plate 52 on which TFT 40 is formed after completion up to process s4.

[0037] In process s5, polyimide resin (product name: JSS-742; made by Japan Synthetic Rubber corporation) is spin coated with 1200 rpm for 20 seconds on the whole surface of the reflection plate 52 in which TFT 40 is formed, to form with a thickness of 2 μm to form an organic insulation film 42. In process s6, using a photolithograph method and dry etching method, a contact

hole 43 is formed on the organic insulation film 42. In process s7, photoresist 50 is coated on the organic insulation film 42 to pattern a circular convex portion 50a on the photoresist 50 in a reflection electrode 38 forming area by using a mask 51 shown in Figure 5. Further, in order to remove a corner of a circular convex portion 50a, heat treatment is performed within a range of 120°C to 250°C. In the present embodiment, the heat treatment was performed with 200°C for 30 minutes. Figure 4(2) shows a cross section of the substrate 31 after completion up to s7. In the mask 51, circular light shield regions 51a shown by a shaded portion are irregularly formed in the reflection electrode 38 forming area.

[0038] In process s8, as shown in Figure 4(3), the organic insulation film 42 of a portion without photoresist 50 is etched to form a circular convex portion 42a with height H of 1.0 µm. At this time, since a corner of the circular convex portion has been removed, the circular convex portion 42a is also formed with a shape of the corner being removed. In addition, organic insulation film 42 on the contact hole 43 and TFT 40 is protected by a photoresist 50; therefore, etching is not made. After completion of etching, photoresist 50 is removed by washing or photo irradiation.

[0039] In process s9, an aluminum layer is formed on the whole surface of the organic insulation film 42 to form a reflection electrode 38 on the circular convex portion 42a, as shown in Figure 4(4). The reflection plate of this state configures a substrate 52 having the reflection electrode 38. The reflection electrode 38 is connected to a drain electrode 37 of TFT 40 via a contact hole 43 formed on the organic insulation

film 42.

[0040] The shape of the mask which determines a shape of the convex portion on the organic insulation film 42 may be a pattern 51 of Figure 5; however, preferably, the shape is formed by a unit pattern shown by square F having a side of 100 to 200 μm as shown in Figure 6(a) and the pattern is designed by utilizing mirror inversion as shown in Figure 6(b). Figure 7 shows an example of a mask 55 designed by utilizing mirror inversion. Here, dotted line 56 in Figure 7 shows a mirror surface.

[0041] The shape of convex portion on the organic insulation film 42 can be controlled by a shape of mask 51 or 55, a thickness of photoresist 50 and a dry etching time; however, the other organic insulation film may be coated.

[0042] With the above-described processes, the reflection plate 52 having the reflection electrode 38 was obtained. In addition, in the above-described production process, by lengthening dry etching time of the organic insulation film 42, the substrate 31 in which each height H is 1 μm for a circular convex portion 42a with various radius can be obtained. The reflection plate 52 having a reflection electrode 38 with the height H of 1 μm configures a substrate 59.

[0043] The electrode 47 formed on the other substrate 45 shown in Figure 1 consists of, for example, ITO and the thickness is 1000A. Orientation films 44, 48 are formed by coating polyimide and the like to be baked. A space to be injected with liquid crystal 49 is formed by screen printing adhesive seal agent (not shown) mixed with spacer of 7 μm between the substrate 52, 45; then by vacuum degassing the space, the liquid crystal 49 is injected. For the liquid crystal 49, for example,

a guest/host crystal in which black pigment is mixed (Product name ZLI2327 made by MERK) mixed with 4.5% optical-active substance (Product name S811 made by MERK) is used.

[0044] Figure 8 is cross section showing a method for measuring a reflection property of a reflection plate 70 having reflection electrode 67. Supposing actually using the reflection plate 70 for a liquid crystal display device, since diffraction index of liquid crystal layer and glass substrate is almost same value of 1.5, by using an ultraviolet cure adhesive resin 63 to seal a glass substrate 62, the measurement apparatus 61 is formed. In the upper region of the glass substrate 62, a photomultimeter 64 for measuring light intensity is arranged. The photomultimeter 64 is fixed in the normal direction of the reflection plate so that the photomultimeter 64 detects a scattered light 66 which reflects in the normal direction of the glass substrate 69 by the reflection electrode 67, of an incident light 65 which enters to the reflection plate 70 with incident angle θ.

[0045] The reflection property of the reflection electrode 67 is obtained by varying the incident angle θ of a incident light 65 entered to the measurement apparatus 61 to measure the scattered light 66 by the reflection electrode 67 in the normal direction.

[0046] Figure 9 is a graph indicating the reflection property of the reflection electrode 38 having a circular convex portion shown in Figure 1. In Figure 9, the reflection intensity of incident light with incident angle θ is indicated as a distance from the origin 0 in the direction of angle θ to the line of θ=0°, in the lateral axis. The reflection property of the

reflection electrode 38 is indicated by a black triangle. The reflection property curve indicated by a white circle was measured for a standard white plate (magnesium oxide).

[0047] Figure 10 is a graph indicating the reflection property 0f a reflection electrode 22 of a conventional circular convex portion shown in aforementioned Figure 14. The reflection property of the reflection electrode 22 is indicated by a black quadrangle. Comparing the reflection property of the reflection electrode 38 having a circular convex portion of the present application and that of a reflection electrode having a conventional circular convex portion, the former has a better reflection property and brighter display can be obtained.

[0048] By selecting a type and a thickness of polyimide resin and a temperature of heat treatment of photoresist as appropriate, a slope angle of concavity and convexity can be freely controlled; thereby the incident angle θ dependency of the reflection intensity can be controlled. The reflection intensity can be controlled also by changing a type or a thickness of organic insulation film coated thereon.

[0049] In addition, by changing a ratio occupied by a light shielding area of a mask 51, the intensity of regular reflection component can be controlled.

[0050] The measurement of reflectivity was performed by placing the above-described reflection type liquid crystal display device at the location of a reflection plate in aforementioned Figure 8. The reflectivity is explained by an incident light entering with incident angle θ and is obtained by calculating a ratio of intensity of scattered light in the normal direction in the display device to that of scattered light in the normal

direction in the standard white plate.

[0051] In the reflection type liquid crystal display device of the present embodiment, since the surface in which reflection electrode 38 of the reflection type active matrix substrate 52 being formed is arranged at liquid crystal layer side, parallax disappears and good display screen is obtained. In addition, in the present embodiment, the constitution is that a reflection thin film of the reflection type active matrix substrate 52 is arranged at the liquid crystal layer side, that is, at the location almost adjacent to the liquid crystal layer; therefore, height H of the convex portion is lower than the thickness of cell, and it is preferable that the slope angle of a convex portion is gradually to an extent that the orientation of liquid crystal is not disturbed.

[0052] Furthermore, in the present embodiment, a patterning of organic insulation film is performed by a dry etching method; however, a wet etching with alkali solution can be used if the organic insulation film is a polyimide resin. In addition, a polyimide resin was used as an organic insulation film; however, other type of organic material such as acryl resin can be used. Furthermore, a glass substrate was used for a substrate in the present embodiment; however, an opaque substrate such as Si substrate can exert similar effect, and in this case, there is a merit for integrating a circuit on the substrate.

[0053] Although in the present embodiment, phase transition type guest/host mode was used as a display mode, without limitation of the embodiment, the reflection type active matrix substrate and a method for producing thereof defined by the present invention can be applied to, for example, other optical

absorption mode such as two layered type guest/host mode, optical scattering type display mode such as a high molecule dispersion type LCD (liquid crystal display device), a double refraction display mode used for ferroelectric LCD and the like. In the embodiment, the case of using TFT as a switching element is explained; however, the invention can be applied to an active matrix substrate using other, for example, MIM (Metal Insulator Metal) element, diode, varistor and the like.

[0054] The substrate using a resist (OFPR-800) as a resin used for organic insulation film has an effect further to reduce interference of light.

[0055]

[Effect of the Invention] As described above, according to the present invention, by using a mask in which circles with a range of diameter of 3 to 50 μm are mixed and the adjacent circles are separated by more than or equal to 1 μm, insulation film of definite pattern in which circles with a range of diameter of 3 to 50 μm of convex portion are mixed and the adjacent circles are separated by greater than or equal to 1 μm is obtained, then a reflection electrode is formed thereon to produce a reflection type liquid crystal display device with good repeatability.

[0056] Designing a mask by utilizing mirror inversing of a unit pattern of square shape having a side of 100 to 200 μm can simplify the mask design, and in addition, a joint of unit pattern is not linear; therefore, a reflection type liquid crystal display having good reflection property can be obtained.

[Brief Description of the Drawings]

[Figure 1] Figure 1 is a cross section of a reflection type

liquid crystal display device 30 which is an embodiment of the present invention.

[Figure 2] Figure 2 is a plan view of a substrate 31 shown in Figure 1.

[Figure 3] Figure 3 is a process chart for explaining a method for forming a reflection electrode 38 having a circular convex portion with diameter of 3 to 50 μm on the substrate 31 shown in Figure 1 and Figure 2.

[Figure 4] Figure 4 is a cross section of the substrate 31 for explaining a forming method shown in Figure 3

[Figure 5] Figure 5 is a plan view of an example of a mask used in a process s7 of Figure 3.

[Figure 6] Figure 6 is a figure for explaining a mirror inversion of a unit pattern.

[Figure 7] Figure 7 is a plan view of a mask 5 designed by mirror inversing a unit pattern.

[Figure 8] Figure 8 is a cross sectional view for explaining a principle of apparatus for measuring a reflection property of a reflection electrode 67.

[Figure 9] Figure 9 is a graph for indicating a reflection property of a reflection electrode having a circular convex portion of the present invention.

[Figure 10] Figure 10 is a graph indicating the reflection property of a reflection electrode 22 having a circular convex portion of the conventional art.

[Figure 11] Figure 11 is a plan view of a substrate 2 of a reflection type liquid crystal display device used for conventional art.

[Figure 12] Figure 12 is a cross section viewed from a

cross-sectional line XI-XI shown in Figure 11.

[Figure 13] Figure 13 is a plan view of a substrate 12 of the other reflection type liquid crystal display device used for conventional art.

[Figure 14] Figure 14 is a cross section viewed from a cross-sectional line XII-XII shown in Figure 13.

[Description of Reference Numerals]

30 reflection type liquid crystal display device

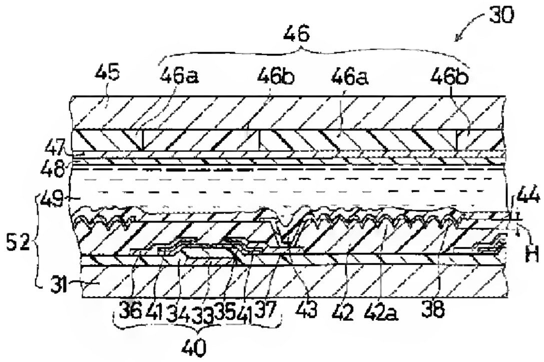
38 reflection electrode

42 organic insulation film

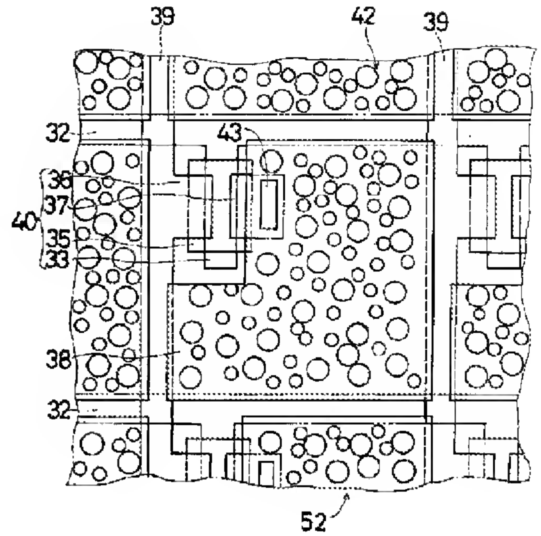
42a circular convex portion

51, 55 mask

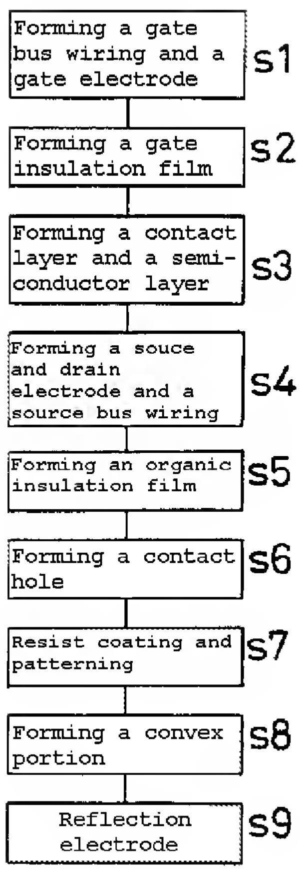
[Figure 1]



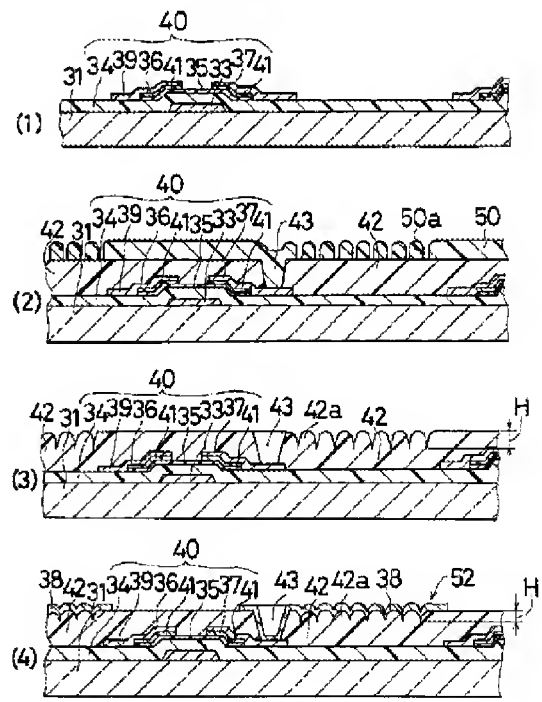
[Figure 2]



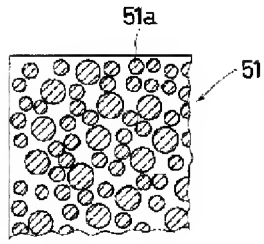
[Figure 3]



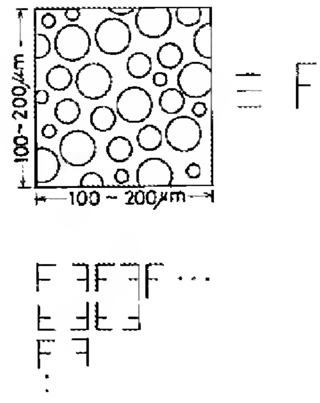
[Figure 4]



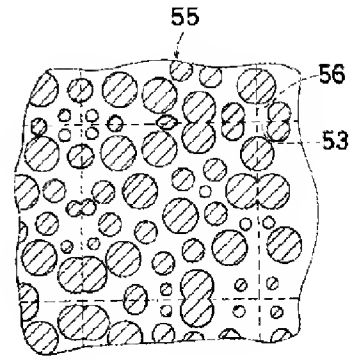
[Figure 5]



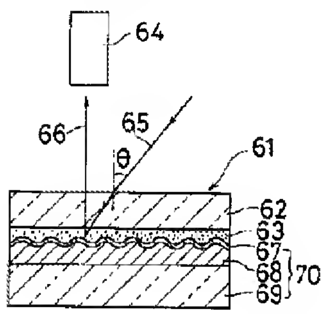
[Figure 6]



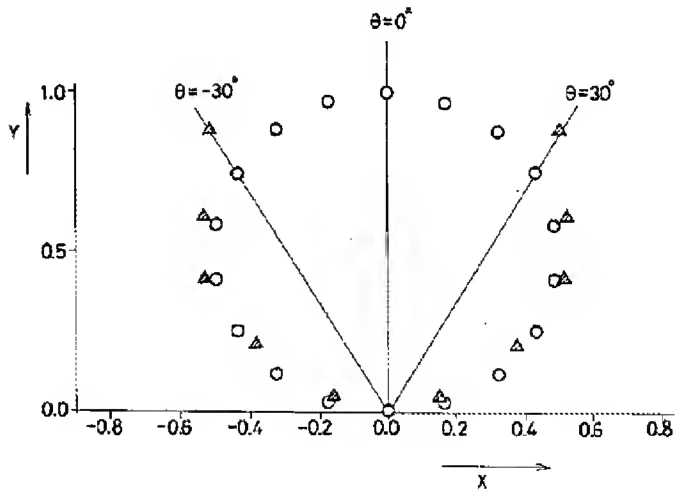
[Figure 7]



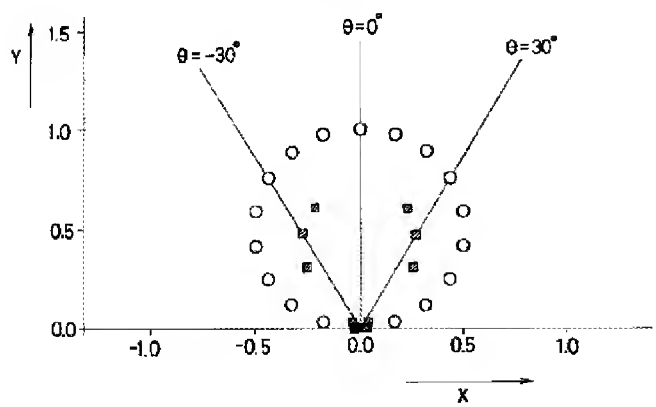
[Figure 8]



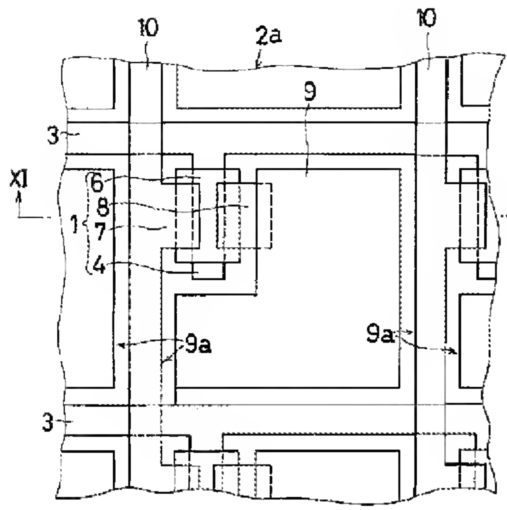
[Figure 9]



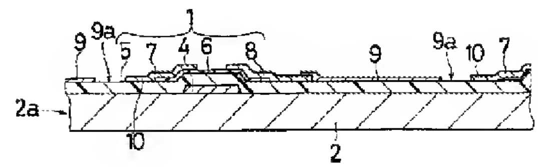
[Figure 10]



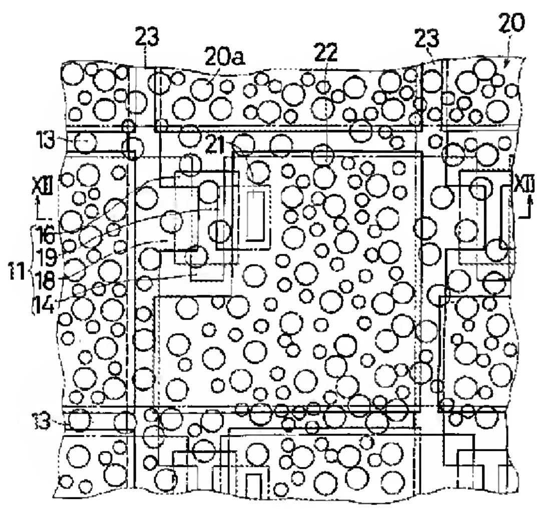
[Figure 11]



[Figure 12]



[Figure 13]



[Figure 14]